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# Hydrogen Sulfide Control in Wastewater Collection Systems

*Tony Palmer, Paul Lagasse and Maureen Ross Dec 28, 2000*

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Hydrogen sulfide (H2S) gas typically is formed in wastewater collection systems that are conducive to creating septic conditions. Collection systems in warm climates that have a flat grade or do not have the flow-through velocities (minimum two feet per second) to prevent the stagnation of fluid, allow the septic conditions to occur. In general, septic conditions occur when bacteria use all of the available oxygen while decomposing organic matter in wastewater for energy. Sewers with low velocities encourage the growth of anaerobic bacteria in a slime layer coating the sewer. These bacteria reduce sulfur compounds such as sulfate (SO4), thereby producing sulfides (SO2). These compounds occur naturally in domestic wastewater but also can be concentrated in industrial waste streams.

Under anaerobic (septic) wastewater conditions, sulfides cannot be oxidized. Therefore, they combine with hydrogen to produce hydrogen sulfide gas, creating the "rotten egg" odor associated with septic wastewater. If the concrete sewer is normally only partly full, the damp surface above the water line is home to aerobic bacteria that oxidize the H2S and produce sulfuric acid (H2SO4) that attacks the calcium carbonate constituents of concrete. The process results in corrosion of the collection system pipes. Corrosion is most severe at the crown of the pipe, where the acid collects, and leads to a weakening of the pipe (or structure) and potential collapses if left unattended.

For existing systems, environmental professionals can resolve corrosion problems with increased ventilation, chemical treatment and the application of protective coatings such as bituminous and coal tar products, vinyl and epoxy resins, plasticized PVC sheets, cement and polyethylene linings, and others. For new construction, a sufficient slope, corrosion-resistant pipe materials and liners can be specified.

One of the more frustrating problems of H2S development from domestic and industrial wastewaters in collection systems is odors. Odor problems often are resolved by chemical addition. Chlorine compounds such as bleach, sodium hypochlorite, calcium hypochlorite and ferric chloride are examples of chemicals that are effective in controlling H2S in wastewater collection systems.

Chemical treatment of your collection system wastewater can be challenging if there are no pumping stations to install a chemical feed system. Confined space limitations, safety issues and space requirements must be considered. Once these challenges are addressed, control and monitoring of your chemical feed system becomes crucial to maintaining an effective and efficient treatment system.

**City of Winnipeg Collection System Odor Control**

The City of Winnipeg has a northern climate, located at the junction of the Red and Assiniboine Rivers in Manitoba, Canada, almost at the geographic center of North America. The City of Winnipeg has a population of approximately 630,000 and provides secondary treatment to an average of 350 million liters of wastewater per day. The city's wastewater collection system is constructed of approximately 2,000 kilometers of wastewater and combined sewers, with 72 wastewater pumping stations that feed three wastewater treatment plants (located at the north, south and west ends of the City).

The City of Winnipeg has a tannery that feeds its industrial wastewater into Winnipeg's wastewater collection system. Tanneries produce high sulfide levels as a consequence of their process. The tannery has its own pretreatment system with the objective of maintaining its sulfide discharge levels below the City's by-law limit of 10 mg/L. However, prior to the installation of pretreatment, and on occasions when the system is bypassed, high sulfide levels were/are sometimes discharged to the sewer.

The sewer line that collects the tannery wastewater has a sufficient slope to provide flow-through velocities, avoiding stagnation problems, and is a 21-inch pipe constructed of sulfate-resistant reinforced concrete. After inspection of the interceptors, it was noticed that corrosion was insignificant. The pipe had some normal cracking but no corrosion.

When pretreatment is inadequate, the tannery wastewater contains a significant amount of sulfides that convert into H2S as it travels through the collection system. The H2S creates a public health concern when the odor reaches street level and at the North End Treatment Plant where the H2S is released form the pump discharge box, grit building and in the open primary clarifiers. The City responded to the local concern by sealing the collection system manholes with polyethylene and working with the tannery to improve pretreatment reliability.

At the North End Treatment Plant, the city adds approximately two to three tons of Cl2 per day for odor control. A consultant report recently recommended increasing this dosage rate by 300 to 400 percent. Winnipeg evaluated alternative chlorine-monitoring technologies used to determine the feed rate of chlorine compounds in the collection system for odor control. Chlorine residual analyzers, which measure chlorine residual in drinking water, require relatively clean effluent to function reliably. Oxidation reduction potential

(ORP) probes, which measure chlorine effectiveness indirectly, have similar limitations.

Winnipeg has put off its investigations of these instruments while looking into non-chemical potential solutions to odor control. Depending on the outcome, the City many resume its search. If it does, one approach it may investigate is measuring H2S, either vapor or liquid phase, and developing an empirical relationship between H2S in the pump discharge box, chlorine dosage and odors in the discharge box, primary clarifiers and grit building at the North End Treatment Plant.

**City of Santa Cruz Collection System Corrosion Control**

The City of Santa Cruz, California, is situated on the northern part of Monterey Bay about 74 miles south of San Francisco and 30 miles from San Jose.

Santa Cruz is the county seat for the County of Santa Cruz. The City has of an area of 12 square miles and an estimated population of 53,200 (1/1/97 California State Department of Finance). The University of California Santa Cruz campus was opened in 1965 and has a population of 10,117 (1996).

The major industries include agriculture, tourism, manufacturing, food processing and high technology firms. About 10 percent of the land area of the County is devoted to state parks, several of which are within or adjacent to the City limits. The climate is mild.

The City of Santa Cruz has been treating wastewater at the facility near Nearys Lagoon and disposing of the effluent in the ocean since 1928. Treatment capacity has been expanded several times since to accommodate the growth of the city and the addition of flows from the Santa Cruz County Sanitation District.

The current rated design capacity is 17 million gallons per day (mgd), with an average daily flow of 12 mgd. Design for wet weather flow is 81 mgd. In April 1998, the City completed a secondary biological treatment system consisting of trickling filters/solids contact tanks to improve effluent quality and satisfy federal requirements and the California Ocean Plan.

The City has a 4-mile long, 36-inch diameter force main in its collection system. The force main collects wastewater from the unincorporated part of Santa Cruz. The force main has average flows of 5 to 20 mgd and is constructed of concrete coated steel pipe.

Santa Cruz had a problem with sulfides in its collection system force main causing odor and corrosion. There are several locations along the force main that have high points where hydrogen sulfide gas can form. The content of the sulfides in the wastewater can be from 20 to 10 ppm, translating into 20 to 200 ppm of hydrogen sulfide gas.

In the past, the force main has broken at some high points because of corrosion caused by hydrogen sulfide gas being trapped. This resulted in very costly repairs to the force main.

The City of Santa Cruz purchased a liquid-phase sulfide ion-selective electrode (ISE) analyzer four years ago (costing about $20,000 to $30,000). The analyzer was installed at the end of the force main near the wastewater treatment plant. The City spent two years researching and further developing the analyzer to ensure accurate and reliable measurement of the sulfides in the raw wastewater.

The analyzer uses a pH buffer chemical reagent to condition the sample to measure total sulfide concentration. This analyzer continuously monitors the amount of sulfides and controls the addition of a proprietary nitrate chemical that is injected upstream in the force main.

The nitrate chemical oxidizes the sulfides present in the wastewater and significantly reduces corrosion and odor. It is crucial that the nitrate chemical be dosed at the proper rate since over dosing can cause sludge to float to the surface of the water in the primaries of the wastewater treatment plant. In addition, the nitrate chemical is costly (approximately $1.50 to $2.50 per gallon, depending on the quantity purchased). Santa Cruz uses anywhere from 200 to 1,000 gallons per day.

Even with its high price the nitrate chemical is preferred over the less costly use of chlorine gas for oxidizing sulfides in this circumstance. This is due to the hazardous nature of storing gas cylinders in residential areas. In addition, the analyzer allows the City of Santa Cruz to download the measurement data collected by computer for further analysis and archiving. Santa Cruz reports that the analyzer is working well.

## Summary

These instrument investigations provided three potential solutions.

• Real-time monitoring of an industrial discharger using a liquid-phase sulfide meter;

• Optimization of chlorine injection for sulfide control by monitoring the sulfides in the collection system and developing an empirical relationship to chlorine dosing; and

• Replacement of chlorine with an alternative chemical that may have a higher chemical cost but would eliminate the public safety and emerging regulatory issues associated with chlorine.

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